Space Weather Technical Forecast

Issued on Wednesday, 07 December 2022 at 00:43 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-Class flares throughout. Chance of G1/Minor Storm late day 1 or day 2 (7-8 Dec). Marginal Active electron fluence possible Day 1 with Chance at end of period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24-hours, with one C1.1 flare peaking at 06/2142 UTC from AR3157.
There are seven numbered regions on the visible disk. By far the largest group remains AR3153 in the southeast. This region has remained relatively stable, despite the emergence and fading of small intermediate spots. AR3158 in the northwest has been reclassified Cai-Beta after the distance between its leading and trailing portions reduced. AR3157 in the northeast has seen spreading between its lead and trailing spots and the emergence of weak intermediate spots, now Esi-Beta. AR3155 in the northwest has seen penumbra emerge around its trailing spots to be reclassified Dai-Beta. AR3159 and AR3160 have recently emerged around the eastern limb. AR3156 is a stable unipolar Hsx-Alpha.
There is no evidence in available imagery of any Earth-bound Coronal Mass Ejections (CMEs).

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by DSCOVR, were suggestive of a gradual exit from a recent fast wind from CH51/+, ending the period at background levels around 330 km/s.
The solar wind density was below average. The IMF was weak below 5 nT, with a north-south range of +3 and -4nT.
The phi angle remained accordingly positive (away from the Sun) throughout.
Geomagnetic activity was Quiet throughout, with Kp levels of 0-2 throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 has remained at Background levels.
High energy electron flux (greater than 2MeV) at GOES16 ranged between Moderate and High in the period, peaking at 2250 pfu at 06/1705 UTC. The associated 24-hour Fluence remained just below the Active (1e8 integrated pfu) threshold through the period. Observed fluence at 07/0001 UTC was 8.85e7 integrated pfu.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to remain at Low levels, with occasional C-class flares and a Chance of isolated M-class flares, most likely from AR3158 and AR3157. The complexity of the current sunspots is not reflective of their observed flare activity. No significant regions are expected to arrive or depart in the next four days.

Solar Wind / Geomagnetic Activity: No Earth-directed components of CMEs feature in the current forecast.
Solar wind speeds are in gradual decline as the residual influence of a fast wind stream from CH51/+ has faded. Enhancement of solar winds to Elevated levels expected either late Day 1 (7th Dec) or during day 2 (8th) due to the arrival of negative coronal hole 53 High Speed Stream. Winds expected to ease by the end of the period as HSS influence wanes.
Geomagnetic activity is expected to remain Quiet during the next 12-18 hours with a chance of Unsettled intervals. Active intervals likely with a Chance of G1/Minor Storms spanning late Day 1 and Day 2 (7-8 Dec), with activity then expected to return to Quiet as connection to the HSS weakens.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) at GEO is expected to remain at Background levels throughout. However, there is a very slight chance of Minor solar radiation storms as sunspot regions rotate westward.
High energy electron flux (greater than 2 MeV), as observed by GOES16, is expected to continue its current diurnal oscillation between Moderate and High levels. Flux levels are expected to fall later on Day 1 (7 Dec) or early Day 2 (8 Dec) in response to geomagnetic activity related to CH53/-. As influence from the HSS wanes, a recovery in electron flux levels is probable either day 3 or 4 (9th/10th Dec).
Fluence levels are currently at Background levels, but very close to the Active threshold (1e8 integrated pfu). Fluence may cross the Active threshold on Day 1 (7th), followed by a probable declining trend due to HSS disruption. Recovery in levels likely on Day 3 or 4 (9/10 Dec), giving a chance of Active fluence.

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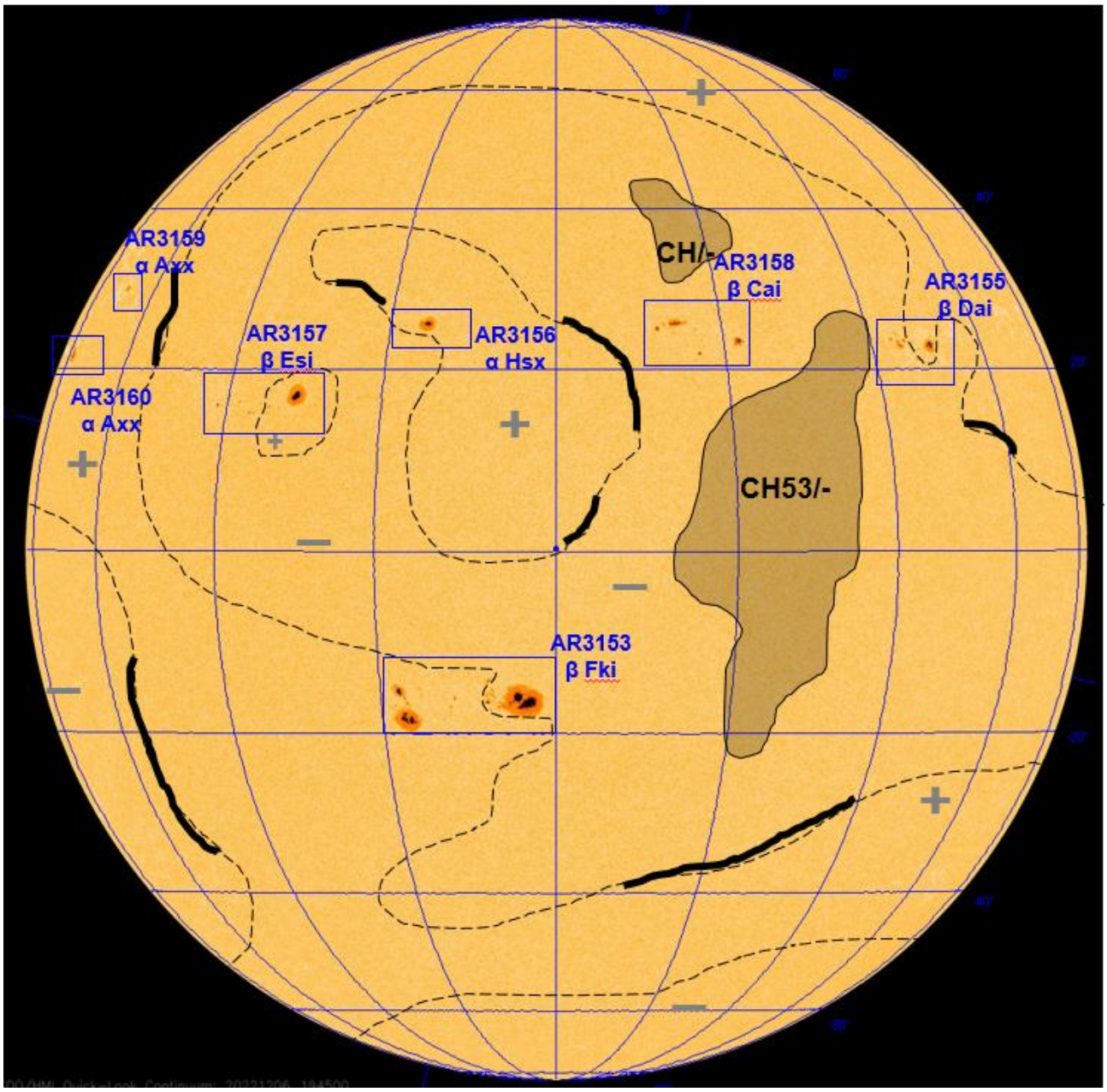
Figure 1. Solar Analysis Valid 06/2000 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Although minor filament eruptions have occurred on the visible disc in the past 24 hours, there was no evidence of any Earth-directed CMEs on available imagery. No Earth-directed CMEs currently feature in the forecast period.

Solar wind speeds are currently at slow-ambient levels around 340 km/s and have been in gradual decline as the residual influence of a fast wind stream from CH51/+ fades. Enhancement of solar winds is expected by late Day 1 (7 Dec) or on Day 2 (8th) due to the anticipated arrival of a high speed stream from the large CH53/- which dominates the western disc in SDO/AIA 211 and 193 imagery. This recurrent feature is larger and much more pronounced relative to the last rotation. Uncertainty as to the effect of this feature lies with these changes as well as the temporal proximity to the solstice and bi-annual minima. Winds expected to gradually ease by the end of the period as HSS influence wanes.

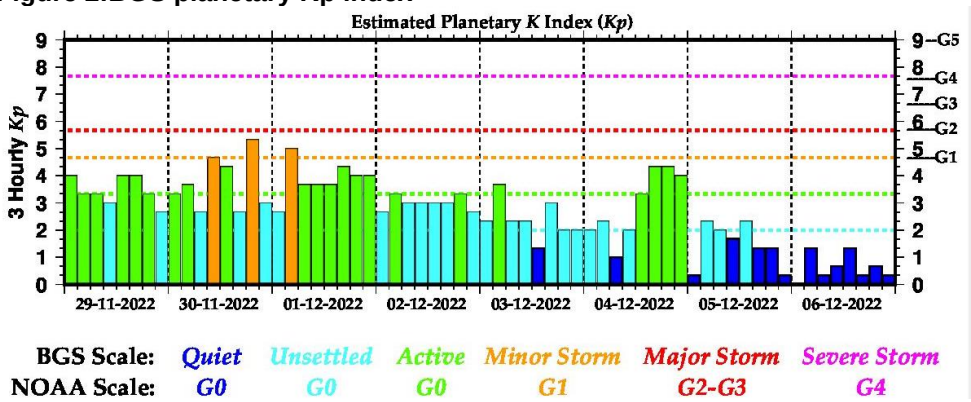
The effects of CH53/- are yet to be observed at STEREO A. MOSWOC Enlil suggests a peak winds of 550 km/s arriving on Day 2 (8 Dec), however onset late on Day 1 is possible with strengths of 550-600 km/s.

Geomagnetic activity is expected to be Quiet during the next 12-18 hours with a chance of isolated Unsettled intervals. The arrival of the HSS from late Day 1 sees Active intervals become likely, with a peak Chance of G1/Minor Storms spanning Days 1 and 2 (7-8 Dec). Geomagnetic activity is expected to return to Quiet as connection to the HSS weakens on Days 3 and 4 (9th/10th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	40	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections- Nil

Figure 2:BGS planetary Kp index



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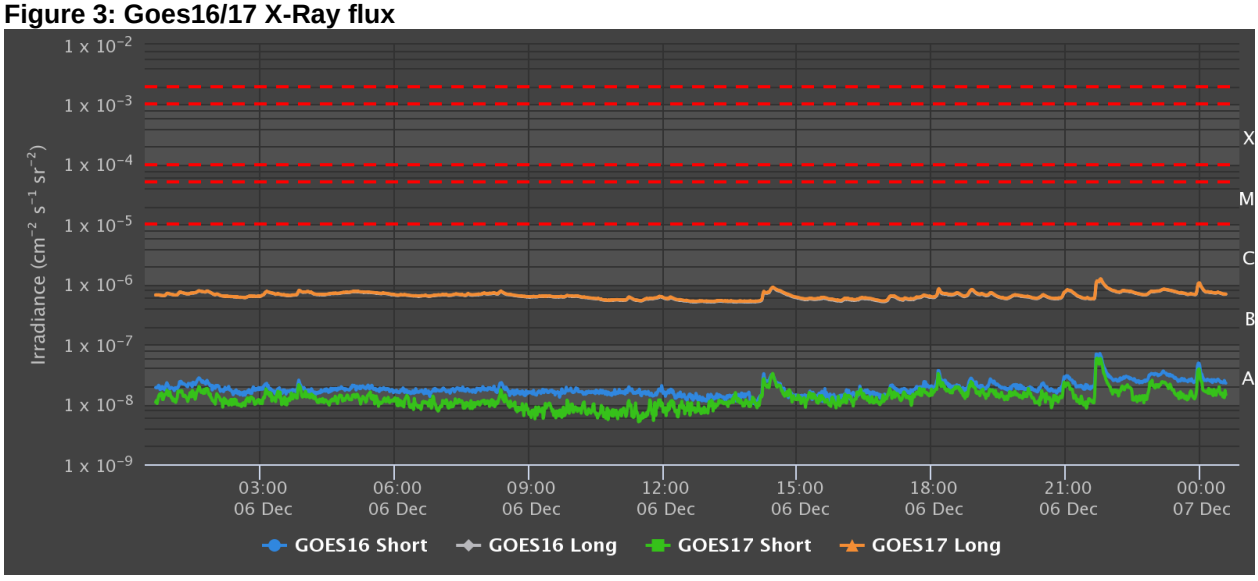
Radio Blackouts - X-Ray Flares:
Solar activity has been Low over the past 24-hours, with one C-class flare. Activity is likely to remain at Low levels, with a daily Chance of increasing to Moderate through the period.
There are seven numbered regions on the visible disk. By far the largest group remains AR3153 in the southeast. This region has remained relatively stable, despite the emergence and fading of small intermediate spots. AR3158 in the northwest has been reclassified Cai-Beta after the distance between its leading and trailing portions reduced. AR3157 in the northeast has seen spreading between its lead and trailing spots and the emergence of weak intermediate spots, now Esi-Beta. AR3155 in the northwest has seen penumbra emerge around its trailing spots to be reclassified Dai-Beta. AR3159 and AR3160 have recently emerged around the eastern limb. AR3156 is a stable unipolar Hsx-Alpha.
One further region may emerge over the eastern limb by Day 3 (9 Dec), otherwise all the sunspots likely to be present in the period are presently on the visible disc.

Despite the suggested complexity of the regions on the visible disc, this has so far failed to manifest in significant flare activity. As such, the daily probabilities of M-Class flare activity have been revised down from the suggested raw values.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Goes16/17 X-Ray flux



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is expected to remain at Background levels throughout. However, there is a daily Slight Chance of seeing S1 or greater levels at GEO. There is an incremental rise in the risk of solar radiation storms as sunspot regions rotate westward, however, this is too minor to be reflected in the percentage risks. Probabilities have also been revised downwards slightly from suggested raw values, due to the observed lack of significant flare activity.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV), as observed by GOES16, is currently demonstrating a diurnal oscillation between Moderate and High flux levels. This pattern is expected to continue until late Day 1 (7 Dec) or early Day 2 (8 Dec), at which point geomagnetic activity resulting from the arrival of CH53 may result in disruption and compression of the radiation belt. As influence from the HSS wanes, a recovery in electron flux levels is likely on Days 3 and 4 (9th/10th).

Levels of electron fluence are currently at Background levels, but very close to the Active threshold (1e8 integrated pfu). Fluence may cross the Active threshold on Day 1, followed by a probable decline due to the arrival of the HSS and a recovery from Day 3 (9 Dec), once more giving a chance of Moderate fluence levels.
Confidence in the above forecast is relatively low, as flux and fluence levels are currently marginal and the driving coronal hole during the period is much-changed from the last rotation

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	60	20	40	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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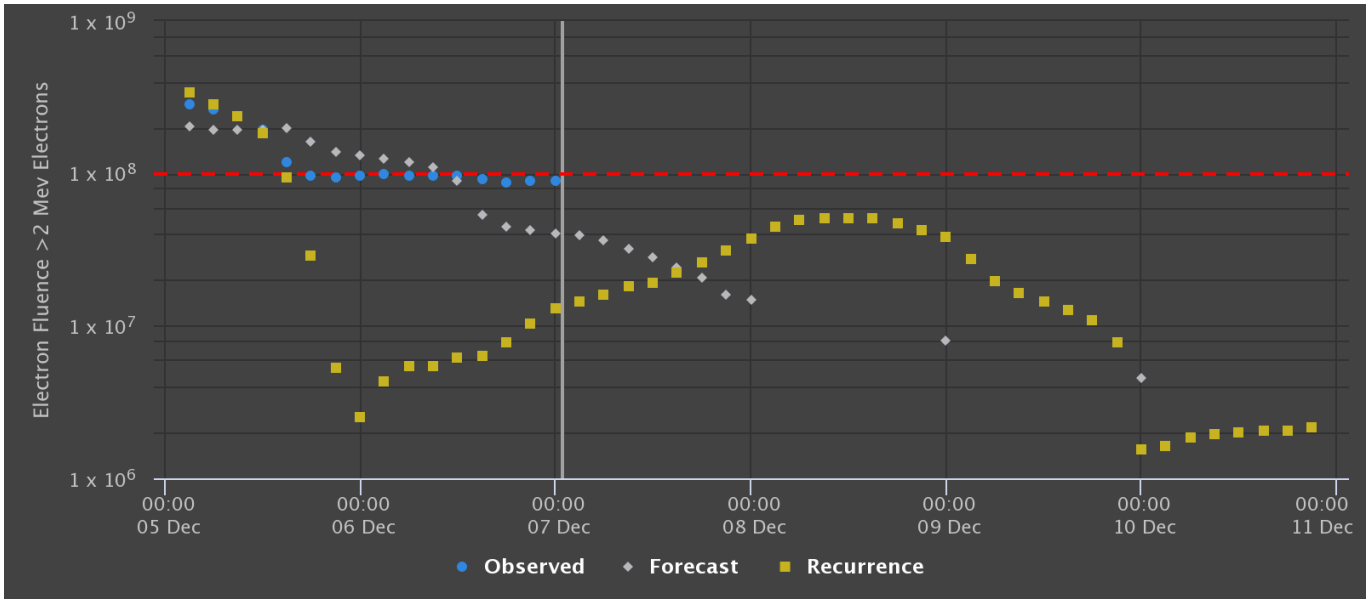
Figure 4: MOSWOC REF Model shows observed values just below the 1e8 integrated Active fluence level.



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